(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 644 467 A1**

EUROPEAN PATENT APPLICATION

Application number: 94114787.8

Date of filing: 20.09.94

(51) Int. Cl.[6]: G03G 15/16, C08L 81/02, B29C 45/00

Priority: 21.09.93 JP 233974/93

Date of publication of application: 22.03.95 Bulletin 95/12

Designated Contracting States: CH DE FR GB LI

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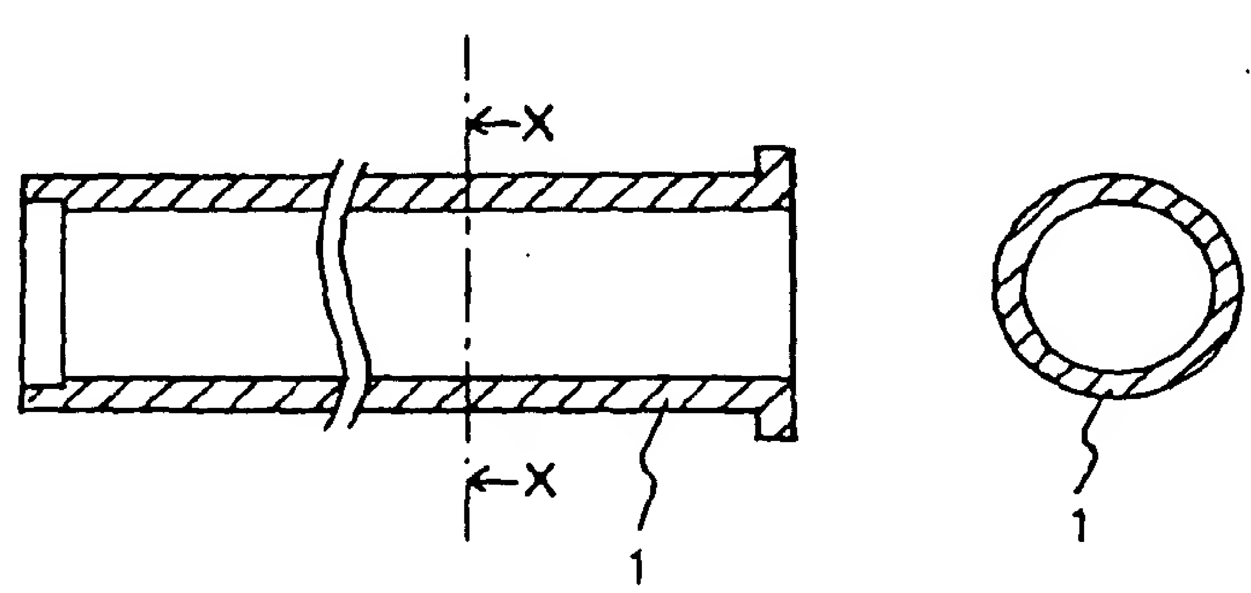
Manufacturing method of organic sensitive body and cylindrical supporting body for electrophotography.

[Object] To provide an organic sensitive body with a cylindrical supporting body that has a light weight with good conductivity and good chemical and thermal resistance, provides dimensional accuracy despite its thin and long shape and also has a uniform surface roughness, stable surface quality, and good adhesion.

[Configuration] A sensitive body is provided by coating and forming a sensitive layer of an organic material on a cylindrical supporting body 1 formed by injection-molding a material 10^4 Ω cm or less in volume resistivity formed by blending a crosslinked-type PPS resin as a main component with a highly conductive carbon black ([illegible] Ω cm or less in volume resistivity).

Fig.1



(a) (b)

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The present invention relates to an organic sensitive body for electrophotography, and, in particular, to a conductive cylindrical supporting body therefor. This invention also relates to a manufacturing method of the conductive cylindrical supporting body.

Prior Art

A sensitive body of electrophotography that is used for an electrophotography device such as a copier or printer to which electrophotography technology is applied comprises a conductive supporting body and a sensitive layer provided thereon and consisting of an organic material containing an organic photoconductive material. The conductive supporting body is usually cylindrical for the convenience of the design of the device, and the sensitive layer is coated and formed on its outer surface.

Conventional materials for the cylindrical supporting body use aluminum or its alloy that has a relatively light weight and a good machinability.

However, Japanese Patent Examined Publication No. 2-17026 discloses a supporting body manufactured by an injection-molding method using a material containing a polyphenylenesulfide resin (simply referred to as PPS below) as a main component, the supporting body that has a light weight and good chemical and thermal resistance, is not oxidized or otherwise deteriorated in the air, and is thus preferable for an organic sensitive body.

Problems to be solved by the invention

Supporting bodies composed of aluminium or its alloy require individual high accuracy machining to obtain a rigid dimensional accuracy ($+50\mu m$ or less in roundness and $+40\mu m$ in the accuracy of diameter) and a preferable surface roughness ($1\mu m$ or less at the max. height (R_{max}) and also require individual machining of a spigot into which a flange for rotatably driving a sensitive body is fitted; have a disadvantage that the surface is oxidized or deteriorated due to the effect of moisture or oxygen in the air; require to prevent deterioration, for example, by forming an anodic oxidized coat on the surface; and thus require many steps and costs in manufacturing process.

Supporting bodies composed of PPS resin as a main component have the following disadvantages. Since the volume resistivity of a PPS resin is high, that is, usually 10^{10} to 10^{13} Ω cm, a carbon black is added to the PPS resin to provide conductivity. The market has recently been making demands on image quality and printing characteristics. Investigations into the conductivity of supporting bodies required to obtain as good image quality and printing characteristics as required in practical use, have revealed that the volume resistivity should be 10^4 Ω cm or less and that a higher volume resistivity prevents the removal of electric charges from the supporting body when the sensitive body is exposed or static electricity is eliminated from the sensitive body, resulting in an increase in residual potential, thereby preventing good images or printed characters from being obtained. The volume resistivity of a furnace carbon, which is usually used as a conductive carbon black, is 1 to 10 Ω cm, and more than 20 wt.% carbon black must be added to provide the supporting body with a volume resistivity of 10^4 Ω cm. However, addition of such a large quantity of carbon black increases the viscosity of the material, making injection-molding difficult. Supporting bodies of a small diameter (about 30 mm or less in outer diameter), a small thickness (about 3 mm or less), and a large length (several hundred mm) which have recently been demanded are very difficult to be made by injection-molding. In addition, such supporting bodies have a reduced mechanical strength. Thinner and longer supporting bodies with dimensional accuracy are more difficult to provide. Supporting bodies composed of an ordinary linear-type PPS resin as a main component are affected by a slight deformation that is caused by a solution of coating liquid or heating during coating and formation of an organic material layer on the supporting body, making the dimensional accuracy required for the supporting body difficult to obtain. In addition, the good chemical resistance of PPS resins prevents the adhesion of an organic material layer to the surface of the resin during coating and formation, causing frequent release of the sensitive layer during the use of the sensitive body, thereby resulting in a short effective life.

In view of the above points, it is an first object of this invention to provide an organic sensitive body with a cylindrical supporting body that has a light weight, a preferable conductivity, and good chemical and thermal resistance, can maintain dimensional accuracy despite its thin and long shape, and is not oxidized nor deteriorated in the air to maintain a stable quality. It is a second object of this invention to provide an organic sensitive body with a cylindrical supporting body that has an adequate and uniform surface roughness. It is a third object of this invention to provide an organic sensitive body with a cylindrical supporting body that has mechanical strength large enough to prevent deformation despite its thin and long

shape. It is a fourth object of this invention to provide an organic sensitive body with a cylindrical supporting body to which an organic material layer can adhere sufficiently during coating and formation. It is the fifth object of this invention to provide an efficient manufacturing method of cylindrical supporting bodies, in particular, those with a small thickness and diameter and a large length, as described in the first, second, and third objects.

[Means for Solving the Problems]

According to this invention, the first object is achieved by providing an organic sensitive body wherein an organic sensitive layer is provided on a cylindrical supporting body composed of a material of 10^4 Ω cm or less in volume resistivity formed by blending a crosslinked-type PPS resin as a main component with a highly conductive carbon black of 10^{-1} Ω cm or less in volume resistivity.

The second object is achieved by providing a cylindrical supporting body wherein the average particle diameter of a carbon black contained therein is 20 to 50 nm.

When a carbon black is added to the supporting body, a carbon black dispersing agent can be preferably added simultaneously to uniformly disperse the carbon black in the supporting body material. The dispersing agent may be a calcium carbonate or clay.

The third object can be achieved by providing a cylindrical supporting body containing glass fibers as a reinforcement.

As described above, the supporting body material is a crosslinked-type PPS resin to which a carbon black, a carbon black dispersing agent, and glass fibers are added; the amount of the crosslinked-type PPS resin should be at least 40 wt.% or more so that the resin can act favorably for the supporting body.

The fourth object can be achieved by irradiating the surface of the cylindrical supporting body with ultraviolet rays 180 to 255 nm in wavelength or inducing corona discharge thereon.

The fifth object can be achieved by injection-molding a material 10^4 Ω cm in volume resistivity formed by blending a crosslinked-type polyphenylenesulfide resin as a main component with a highly conductive carbon black 10^{-1} Ω cm or less, or the above material wherein the average particle diameter of the carbon black is 20 to 50 nm or to which glass fibers are added.

The metal mold for injection-molding is preferably heated within a range of 120 °C to 150 °C and molding material is preferably heated within a range of 280 °C to 330 °C. Filling of an injection-molding material is preferably completed in 0.05 to 2.5 seconds.

It is also preferable to use a mold wherein a core mold is finished to have a surface roughness of 1 µm or less at the maximum height (R_{max}) and a draft angle of 0.15° to 0.25° on one side, wherein the inner surface of a cavity mold does not have a draft angle, is electroformed with a nickel alloy, is finished to have a surface roughness of 1 µm or less at the maximum height (R_{max}), and has inside of the end face that contacts a fixed mold a stage section via which a material is filled into a cavity using a side gate method, and wherein the circumference of the cavity mold is sectioned into at least three at the end face of the fixed mold that contacts the cavity mold and a spring knock is provided in each section to ensure that when the mold is opened, the injection-molded product remains in the cavity mold due to the effect of the spring knock.

[Effects of the Invention]

Table 1 shows the chemical resistance of both crosslinked-type and linear-type PPS resins evaluated in terms of changes in mass (%) after immersion in acetone, methylene chloride, and dichloroethane respectively for 24 hours using cylindrical molded products composed of the respective resins, and their thermal resistance evaluated in terms of changes in diametral and longitudinal dimensions (%) after heating at 120 °C for 48 hours.

Table 1

Properties	Linear-type PPS resin	Crosslinked-type PPS resin
Chemical resistance (changes in mass after immersion for 24 hours (%))		
acetone	+ 0.05	0
methylene chloride	+ 12.42	+ 0.13
dichloroethane	+ 3.40	0
Thermal resistance (changes in dimensions 48 hours after heating at 120 ° C (%))		
diametral direction	0.67	- 0.01
longitudinal direction	- 1.20	0

As is apparent from Table 1, the crosslinked-type PPS resin is superior to the linear-type PPS resin in terms of both chemical and thermal resistance. The formation of a supporting body with a crosslinked-type PPS resin as a main component reduces swelling caused by the thermal deformation of the supporting body, or a solution of coating liquid during the coating and formation of an organic material layer such as a sensitive layer, also reduces the deformation of the supporting body, and provides practically sufficient dimensional accuracy even for an sensitive body using a supporting body of a small thickness and diameter with a large length.

The addition of a highly conductive carbon black of 10^{-1} Ω cm in volume resistivity, for example, as [illegible] conductive carbon black or a more highly conductive channel black into a material containing a crosslinked-type PPS resin as a main component in order to apply conductivity to the material, reduces to [illegible] or less the quantity of carbon black to be added to the supporting body to reduce its volume resistivity to 10^4 Ω cm or less, and possibly keeps the viscosity of the supporting body material low enough to allow the supporting body to be injection-molded despite its small diameter and thickness and large length; for example, the melt flow rate (MFR) can be maintained within a range of 20g/10min. to 50g/10min. at [illegible] °C

Of course, the carbon black is preferably dispersed uniformly in the supporting body material. To do this, a dispersing agent is desirably added to the material; applicable dispersing agents include a calcium carbonate and clay. Although the quantity of dispersing agent to be added depends on the quantity of carbon black to be added, it should be 10 to 30 wt.% of the supporting body material. Less than 10 wt.% of dispersing agent has no effects, while more than 30 wt.% of dipersing agent is not preferable due to its adverse effect on the conductivity of the material.

Although the surface roughness of the supporting body depends upon the surface roughness of the inner surface of the cavity mold of the metal mold, it is affected greatly by the particle size of the carbon black. A carbon black 20 to 50 nm in average particle diameter enables the surface roughness of the supporting body to be within a range of 0.5 to 1.2 µm at R_{max}.

The addition of glass fibers to the supporting body compensates for a decrease in mechanical strength caused by the addition of a carbon black, providing strength of 0.49 x 10^8 N/m^2 or more required for a supporting body about 1 mm in thickness. The glass fiber preferably has a diameter of 20 µm and a length of 3 mm. Although the quantity of glass fibers to be added depends on the quantity of carbon black to be added, it should be 10 to 30 wt.% of the supporting body material. Less than 10 wt.% of glass fibers have no effects, while more than 30 wt.% of glass fibers are not preferable due to its adverse effect on the conductivity of the material and the surface roughness of the supporting body.

As described above, the supporting body is a crosslinked-type PPS resin to which a carbon black, a carbon black dispersing agent, and glass fibers are added; provision of at least 40 wt.% or more of resin allows it to function effectively without losing its character.

A disadvantage of the PPS resin is its low adhesion. In the electronics- and automobile-related field in which PPS resins are used as engineering plastics, methods for irradiating the surface with ultraviolet rays or inducing corona discharge thereon to modifiy the surface to improve adhesion have been known (The Adhesion Society of Japan 31st Annual Convention (June, 1993): Improvement of PPS Adhesion; Journal of The Adhesion Society of Japan Vol. 29, No. 4 (1993): Improvement of Surfaces Using Ultraviolet Rays). However, it has been unknown whether or not these methods can be used effectively without degrading the functions of the supporting body if a crosslinked-type PPS resin is used as a functional material for the

supporting material of sensitive body. The inventors discovered that irradiation with ultraviolet rays of 180 to 255 nm in wavelength causes ozone to be generated from oxygen in the air due to ultraviolet energy to cut molecular chains on the utmost surface of the crosslinked-type PPS resin and to generate a -OH and a -COOH group due to the additional effect of moisture in the air to activate the surface, thereby substantially improve the wettability and adhesion of the surface. Corona discharge energy also causes ozone to be generated to produce effects similar to those in irradiation with ultraviolet rays.

The supporting body for a sensitive body in accordance with this invention is made by injection-molding a material containing a crosslinked-type PPS resin as a main component to which a carbon black, a carbon black dispersing agent, and glass fibers are added. A supporting body with required shape and surface roughness can be manufactured accurately and efficiently by integrally forming a metal mold with an adequate structure under adequate molding conditions. This obviates the need of individual surface-roughness-machining and other machining processes required when an aluminum alloy is used to manufacture a supporting body.

Heating the metal mold within a range of 120 to 150 °C during injection-molding; heating the molding material within a range of 280 to 330 °C; applying sufficient injection pressure; and completing filling of a material in 0.05 to 2.5 second allow the material filling to be completed before the resin starts to be solidified within the cavity (material-filled section) to provide a well-shaped supporting body, and cause the resin to be crystallized sufficiently to enable the crosslinked-type PPS resin to function effectively.

Next, the effects of the metal mold used to manufacture the supporting body in accordance with this invention are described with reference to the drawings. Figures 3 through 5 are partially sectional views describing an embodiment of the metal mold in accordance with this invention. Figure 3 shows the closing condition in which the end face of a cavity mold 6 contacts firmly to the end face of a fixed mold 8, wherein reference numeral 7 designates a core mold and reference numeral 9 is a cavity into which a molding material is filled and molded. Figure 4 shows the opening condition in which the cavity mold 6 and the fixed mold 8 are separated after molding. Reference numeral 14 designates a molded product. The core mold 7 is fitted into the fixed mold 8 and fixed thereto. Figure 5 is a partially enlarged sectional view of a spring knock 11 and its periphery in Figure 3. Reference numeral 12 designates a spring, while reference numeral 13 designates a knockout pin.

A stage section 10 is formed inside of the end face of the cavity mold 6 that contacts the fixed mold 8. (h) in the stage section 10 shown in Figure 5 should preferably be 1 to 3 mm and (w) should be 2 to 5 mm. In the closing condition shown in Figure 3, when a molding material is filled into the cavity 9 via this stage section 10 using side gate method, the material fills the stage section 10 and then the thin cylinder-like cavity 9, allowing the cavity 9 to be filled quickly, and circumferentially uniformly up to its tip of cavity 9 without producing defects such as a weld line. A gas vent is preferably provided at the tip of the cavity 9, and if desired, vacuum venting is preferably enabled to fill a molding material quickly in 0.05 to 2.5 second. The inside of the cavity mold 6 is electroformed with a nickel alloy to allow the molded product to be molded and released properly, and its surface roughness is finished to be 1 µm or less at the maximum height (R_{max}). The use of the cavity mold 6 with such surface conditions to fill and solidify a material in the cavity 9 at a sufficient injection pressure results in an injection-molded supporting body whose surface roughness is 1 µm or less at the maximum height (R_{max}).

A uniform outer diameter is required for a sensitive body, and a draft angle must not be applied in the outer diameter of a molded product. Such molded products, in particular, those with a small thickness are difficult to release from the cavity mold 6 without damaging their surface. The surface of the core mold 7 is finished to be smooth so that its surface roughness is 1 µm or less at the maximum height (R_{max}). A draft angle within a range of 0.15° to 0.25° is provided on one side. The fixed mold 8 is provided with at least three spring knocks 11 comprising knockout pin 13 and a spring 12 at its end face opposite to the circumference of the end face of the cavity mold 6. This configuration causes the spring 12 compressed during closing as shown in Figure 5 to extend upon opening, thereby causing the tip of the knockout pin 13 to protrude from the end face of the fixed mold 8 as shown in Figure 4. The length by which the tip of the knockout pin protrudes from the end face is (m) shown in Figure 5. Thus, when the fixed mold 8 is separated from the cavity mold 6 and opened after molding, the tip of the knockout pin 13 continues pushing the end faces of the cavity mold 6 and molded product until the two molds 6 and 8 are separated by the distance equal to length (m). The cavity mold 6 and the molded product 14 thus move integrally, and, after opening, the molded product 14 is detached from the core mold 7 and remains fixed to the cavity mold 6, as shown in Figure 4. Since the core mold 7 has a draft angle and its surface is finished to be smooth, the core mold 7 can be pulled out smoothly from the molded product 14. Once the core mold has been pulled out, the molded product 14 contracts diametrally, allowing the molded product 14 to be, for example, knocked out from the cavity mold 6 without damaging its surface. If the draft angle of the core

mold 7 is less than 0.15° on one side, the core mold is difficult to remove; if the draft angle is more than 0.25° on one side, the thickness of the thinner end of the supporting body, which is a molded product, will be too small to carry out molding if the supporting body is about 3 mm or less in thickness. For example, when the draft angle is 0.25° on one side and a supporting body of 30 mm in OD, 300 mm in length, and 1.5 to 3 mm in thickness of the thicker end is used, the thickness of the thinner end will be 0.3 to 0.6 mm if the thickness of the thicker end is 1.5 to 3 mm, making molding very difficult. The draft angle should thus be within a range of 0.15° to 0.25° on one side.

Figure 6 is a perspective view illustrating a molded product removed from the metal mold, wherein a ring-like projection 15 is formed at one end of the cylindrical supporting body 1 so as to correspond to the stage section 10 of the cavity mold 6. Reference numeral 16 designates a side gate.

[Embodiments]

Figure 1 is a typical cross-sectional view of an embodiment of supporting body for a sensitive body in accordance with this invention. Figure 1(a) is a longitudinal section of a supporting body 1, and Figure 1(b) is a cross-sectional view taken along line X-X of Figure 1(a). Figure 2 is a typical cross-sectional view illustrating the configuration of the layers of an embodiment of sensitive body. In this figure, a sensitive layer 3 is formed by laminating via an under-layer 2 an electric charge generation layer 4 and an electric charge transport layer 5 in this order on the supporting body 1 shown in Figure 1. The under-layer 2 is not always necessary but is provided when needed.

Embodiment 1

Using materials 1-1 to 1-4 of the compositions shown in Table 2 and a metal mold shown in Figures 3 to 5, supporting bodies 1 to 3 were formed by injection-molding under the same molding conditions, while a supporting body 4 was formed by injection-molding at a different metal mold temperature using a material 1-4 composed of a linear-type PPS resin. The injection-molding was carried out using a draft angle of about 0.23° on one side to obtain supporting bodies with an outer diameter of 30 mm, a length of 260.5 mm, and an inner diameter of 28.5 mm for the thinner end and 26.5 mm for the thicker end.

Table 2

Raw material	Raw material brand	Compounding ratio (wt.%)			
		Material 1-1	Material 1-2	Material 1-3	Material 1-4
Crosslinked-type PPS resin	Toray PPS M2900 (MFR:600)	60	-	-	-
	Toray PPS M3910 (MFR:2000)	-	50	50	-
Linear-type PPS resin		-	-	-	50
Carbon black	Cabot Furnace Carbon XC72 particle size: 30 nm	15	-	-	-
	Cabot Furnace Carbon BP-480 particle size:30 nm	-	20	10	20
Clay	Tsuchiya Kaoline SATINTONES	10	15	25	15
Glass fibres	Nihon Sheet Glass RES 03-TP76 diameter: about 20μm length: about 3mm	15	15	15	15

Table 3

Supporting body No.	1-1	1-2	1-3	1-4
Supporting body material	Material 1-1	Material 1-2	Material 1-3	Material 1-4
Cylinder temperature (°C) rear middle front	 280 290 300	Same as the values on the left	Same as the values on the left	 280 290 300
Nozzle temperature (°C)	310			300
Metal mold temperature (°C)	150			120
Injection pressure ($\times 10^8$ N/m^2)	1.62			1.62
Filling time (sec)	0.1			0.1
Cooling time (sec)	30			30

The following sensitive layers were formed on these supporting bodies under the same conditions to produce sensitive bodies. That is, a coating liquid with 5 pts.wt. alcohol-soluble polyamide resin (manufactured by Toray Co., Ltd.; Amilan CM 8000) solved in 95 pts.wt. methanol was coated on a supporting body by a dipping method and then dried at 120°C for 15 minutes to form an under-layer 0.5 μm in thickness. A coating liquid formed by blending and dispersing 10 pts.wt. X-type non-metal phthalocyanine (manufactured by Dainippon Ink and Chemicals Inc.; FASTGEN BLUE 8120), 10 pts.wt. vinyl chloride resin (manufactured by Nippon Zeon Co., Ltd.; MR-110), 686 pts.wt. dichloromethane and 294 pts.wt. 1, 2 -dichloroethane in a mixer for one hour and further dispersing the mixture by a supersonic dispersing machine for 30 minutes, was coated on the under-layer by a dipping method and then 0.5μm in film thickness. A coating liquid consisting of 100 pts.wt. hydrazone compound (manufactured by Fuji Electric Co., Ltd.) shown in structural formula (1), 100 pts.wt. polycarbonate resin (manufactured by Mitsubishi Gas Chemical Co., Ltd.; Iupilon PCZ), and 800 pts.wt. dichloromethane was coated on the electric charge generation layer by a dipping method and then dried at 90°C for one hour to form a electric charge transport layer of 0.2 μm in thickness, thereby producing a sensitive body.

Formula 1

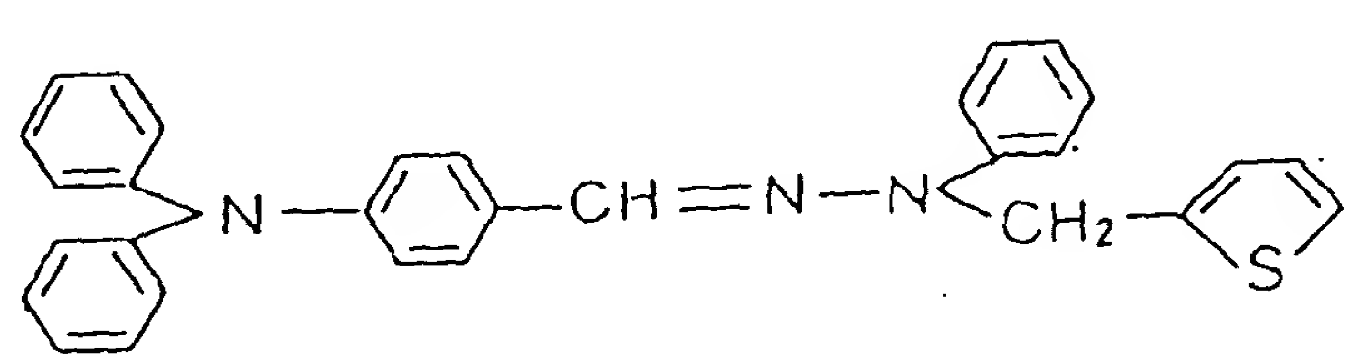

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Table 4 shows the MFR at 300°C, volume resistivity, injection-moldability, mechanical strength, and chemical resistance (evaluated in terms of changes in mass during immersion in a methylene chloride for two hours) of the supporting body material, and the surface roughness (at the maximum height R_{MAX}), outer diameter accuracy, and change in dimensions measured after heating at 120°C for 48 hours each of supporting body, and the potential retaining rate V_{k5} measured after 5 seconds after charging in a dark place, residual potential V_r measured after irradiation of 10 μJ/cm^2 with monochromatic light 780 nm in wavelength, and the printing characteristics evaluated by installing the sensitive body in a commercially available semiconductor laser printer of each sensitive body.

Table 4

Sensitive body No.	1-1	1-2	1-3	1-4
Supporting body No.	1-1	1-2	1-3	1-4
MFR (g/10 min.)	30	40	30	40
Volume resistivity (Ω cm)	2×10^3	3×10^2	10^6	3×10^2
Injection moldability	good	good	good	nearly good
Mechanical strength ($\times 10^8$ N/m^2)	0.68	0.68	0.74	0.78
Chemical resistance (%)	10.5	10.1	10.1	12.4
Surface roughness R_{max} (μm)	0.9	0.8	0.8	0.8
Outer diameter accuracy (mm)	0.05	0.03	0.03	0.05
Dimensional change rate (%)	0	0	0	-0.7
V_{k5} (%)	90	92	93	92
V_r (V)	31	34	60	35
Printing characteristics	good	good	bad	nearly good

As can be seen from Table 4, the supporting body 1-4 using the material 1-4 composed of a linear-type PPS resin as a main component has inferior chemical resistance than that of the supporting bodies 1-1, 1-2, and 1-3 using the materials 1-1, 1-2, and 1-3 respectively composed of a crosslinked-type PPS resin as a main component, while it has a larger dimensional change rate than that of the supporting bodies 1-1, 1-2, and 1-3. In addition, the sensitive body 1-3 using the supporting body 1-3 with a high volume resistivity of 10^6 Ω cm has bad printing characteristics. It is obvious that supporting bodies consisting of a material comprising a crosslinked-type PPS resin as a main component and having volume resistivity of 10^4 Ω cm or less can produce good effects.

Embodiment 2

An ultraviolet ray irradiation device (SUV200NS) manufactured by Sen Engineering Co., Ltd. was used to irradiate the surface of the supporting body 1-1 described in Embodiment 1 with ultraviolet rays 184.9 and 253.7 nm in wavelength from a 200 W low pressure mercury lamp, keeping a distance of 20 mm from the supporting body. The supporting body irradiated for 10 seconds was referred to as 2-1, while the supporting body irradiated for 20 seconds was referred to as 2-2.

In addition, corona discharge was induced on the surface of the supporting body 1-1 while it was being rotated (discharge voltage: about 10 kV; gap between a discharge electrode and the supporting body: 2 to 3 mm; and discharge time: 30 seconds). This supporting body was referred to as 2-3.

For comparison, the supporting body 1-1 on which ultraviolet ray irradiation corona discharge were not induced was referred to as 2-4.

The contact angle of the surface of these supporting bodies with respect to pure water was determined, and cross-cut adhesion tests (JIS K5400 8.5.1) were conducted to evaluate adhesion.

Each supporting body was used to produce sensitive bodies 2-1, 2-2, 2-3, and 2-4 as in Embodiment 1. The sensitive bodies were then installed in a commercially available semiconductor laser printer to evaluate their continuous printing life, that is, when their sensitive layer starts being separated from the supporting body.

Table 5 shows the results.

Table 5

Sensitive body No.	2-1	2-2	2-3	2-4
Supporting body No.	2-1	2-2	2-3	2-4
Surface treatment ultraviolet ray irradiation (second) corona discharge (second)	10 -	20 -	- 30	- -
Contact angle (degree)	32	0	0	78
Cross-cut adhesion test (separations/100)	85/100	0/100	0/100	100/100
Continuous printing life (times)	50.000	100.000	100.000	5.000

Table 5 clearly shows that the sensitive bodies 2-1 and 2-2 using the supporting bodies 2-1 and 2-2 irradiated with ultraviolet rays and the sensitive body 2-3 using the supporting body 2-3 on which corona discharge was induced were better in adhesion and continuous printing life than the sensitive body 2-4 using the supporting body 2-4 on which no treatments were applied. For irradiation with ultraviolet rays from a 200 W low pressure mercury lamp, the results were particularly good when the irradiation time was 20 seconds. It can thus be estimated that the irradiation time is preferably 15 to 25 seconds.

Embodiment 3

The material 1-3 in Table 2 and the metal mold in Figures 3 to 5 were used to carry out injection-molding at various metal mold temperatures as shown in Table 6 to produce supporting bodies 3-1, 3-2, and 3-3. The nozzle temperature was somewhat changed along with the variation of the metal mold temperature. For the supporting material 3-3, an increase in metal mold temperature results in a shorter material-filling time. Among the supporting bodies formed, the supporting body 3-3 was inadequate for practical use due to many burrs. The supporting bodies 3-1 and 3-2 were then used to produce sensitive bodies 3-1 and 3-2 as in Embodiment 1 to determine their potential retaining rate V_{k5}, residual potential V_r and printing characteristics. Table 7 shows the results.

Table 6

Supporting body No.	3-1	3-2	3-3
Cylinder temperature (°C) rear middle front	 280 290 300	 280 290 300	 280 290 300
Nozzle temperature (°C)	310	300	319
Metal mold temperature (°C)	150	100	170
Injection pressure (x 10^8 N/m^2)	1.62	1.62	1.57
Filling time (sec)	0.1	1.0	0.04
Cooling time (sec)	30	30	30

Table 7

Sensitive body No.	3-1	3-2
V_{k5} (%)	92	93
V_r (V)	34	55
Printing characteristics	good	bad

As is apparent from Tables 6 and 7, good supporting bodies cannot be obtained unless adequate injection-molding conditions are set even if the same material is used. Good results can be obtained when the metal mold temperature is 150 °C, while printing is bad when this temperature is 100 °C and many burrs are generated when this temperature is 170 °C. It can be estimated that the metal mold temperatures is preferably higher than 100 °C and lower than 170 ° C, and, more preferably, within a range of about 120 ° to about 160 °C.

[Advantages of the Invention]

With the above configuration, this invention has the following advantages:

The use of a material 10^4 Ω cm in volume resistivity formed by blending a crosslinked-type PPS resin as a main component with a highly conductive carbon black 10^{-1} Ω cm or less serves to provide an organic sensitive body with a cylindrical supporting body that has a light weight, preferable conductivity, and good chemical and thermal resistance, can effectively maintain dimensional accuracy despite its thin and long shape, and is not deteriorated by oxidation in the air, thereby eliminating the need of a special treatment for surface stabilization.

Blending with a carbon black 20 to 50 nm in average particle diameter serves to provide an organic sensitive body with a cylindrical supporting body that has a uniform surface roughness within a range of 0.5 to 1.2 μm at R_{max}. When the carbon black is added to the supporting body, a carbon black dispersing agent can preferably be added together to uniformly add the carbon black, thereby making the supporting body homogeneous and the surface roughness uniform.

The addition of glass fibers serves to provide an organic sensitive body with a cylindrical supporting body that has a high mechanical strength and is difficult to deform despite its thin and long shape. Glass fibers about 20 μm in diameter and about 3 mm in length are preferable due to the lack of adverse effects on the surface roughness of the supporting body. The addition of various materials does not affect the favorable characteristics of the supporting body as long as at least 40 wt.% or more of the supporting body material is composed of a crosslinked-type PPS resin.

Irradiating the surface of the supporting body with ultraviolet rays 180 to 255 nm in wavelength or inducing corona discharge thereon serves to provide a long life organic sensitive body with a cylindrical supporting body that has better adhesion and on which an organic material layer can be formed stably.

The above cylindrical supporting body can be manufactured efficiently by injection-molding a material 10^4 Ω cm in volume resistivity formed by blending a crosslinked-type PPS resin as a main component with a highly conductive carbon black 10^{-1} Ω cm or less in volume resistivity, or the above material wherein the average particle diameter of the carbon black is 20 to 50 nm or to which glass fibers are added.

The above molding material can be molded effectively and the crosslinked-type PPS resin is crystallized sufficiently to act favorably for the supporting body when the mold temperature is within a range of 120 ° to 150 °C and the molding material temperature is within a range of 280 ° to 330 °C. Completion of filling of a material in 0.05 to 2.5 seconds preferably serves to form efficiently a thin and long cylindrical supporting body. In the metal mold used, the core mold fitted into the fixed mold is finished to have a surface roughness of 1 μm or less at the maximum height (R_{max}) and a draft angle of 0.15 ° to 0.25 ° on one side; the inner surface of the cavity mold does not have a draft angle; is electroformed with a nickel alloy; is finished to have a surface roughness of 1 μm or less at the maximum height (R_{max}); and has inside its end face that contacts the fixed mold a stage section via which a material is filled using a side gate method; the fixed mold is provided with at least three spring knocks at its end face opposite to the end face of the cavity mold to ensure that when the mold is opened after molding, the injection-molded product remains in the cavity mold due to the effect of the spring knock. The use of a metal mold of this configuration serves to easily reduce the molding material filling time down to 0.05 seconds, allows the molding material to be uniformly filled circumferentially up to the tip of the cavity before the material starts to be solidified, and enables thin and long supporting bodies to be formed adequately. Supporting bodies 1

μm in surface roughness at the maximum height (R_{max}) can also be obtained corresponding to the roughness of the inner surface of the cavity mold. When the mold is opened after injection-molding, the core mold can be pulled out smoothly from the molded product due to its draft angle, which can then be, for example, knocked out from the cavity mold without damaging its surface.

[Brief Description of the Drawings]

Figure 1 is a typical sectional view of an embodiment of a supporting body in accordance with this invention; Figure 1(a) is a longitudinal section, while Figure 1(b) is a cross-sectional view taken along line X-X of Figure 1(a).

Figure 2 is a typical sectional view of an embodiment of a sensitive body in accordance with this invention.

Figure 3 is a partially sectional view of the closing condition describing an embodiment of a metal mold in accordance with this invention.

Figure 4 is a partially sectional view of the opening condition describing an embodiment of a metal mold in accordance with this invention.

Figure 5 is a partially enlarged sectional view of a spring knock section and its periphery in Figure 3.

Figure 6 is a perspective view illustrating a molded product removed from the metal mold.

[Description of Symbols]

1	Supporting body
2	Under-layer
3	Sensitive layer
4	Electric charge generation layer
5	Electric charge transport layer
6	Cavity mold
7	Core mold
8	Fixed mold
9	Cavity
10	Stage section
11	Spring knock
12	Spring
13	Knockout pin
14	Molded product
15	Ring-like projection
16	Side gate

Claims

1. An organic sensitive body for electrophotography comprising an organic sensitive layer on a cylindrical supporting body composed of a material 10^4 Ω cm in volume resistivity formed by blending a crosslinked-type polyphenylenesulfide resin as a main component with a highly conductive carbon black 10^{-1} Ω cm or less in volume resistivity.

2. The organic sensitive body for electrophotography of Claim 1 wherein the average particle diameter of the carbon black contained in the cylindrical supporting body is 20 to 50 nm.

3. The organic sensitive body for electrophotography of Claim 1 or 2 wherein the cylindrical supporting body contains a carbon black dispersing agent.

4. The organic sensitive body for electrophotography of Claim 3 wherein the dispersing agent is a calcium carbonate or clay.

5. The organic sensitive body for electrophotography of any of Claims 1 to 4 wherein the cylindrical supporting body contains glass fibers as a reinforcement.

6. The organic sensitive body for electrophotography of any of Claims 1 to 5 wherein the amount of the crosslinked-type polyphenylenesulfide resin contained in the cylindrical supporting body is at least 40 wt.% or more.

7. The organic sensitive body for electrophotography of any of Claims 1 to 6 wherein the surface of the cylindrical supporting body is irradiated with ultraviolet rays 180 to 255 nm in wavelength.

8. The organic sensitive body for electrophotography of any of Claims 1 to 6 wherein corona discharge treatment is induced on the surface of the cylindrical supporting body.

9. The organic sensitive body for electrophotography of any of Claims 1 to 8 wherein the thickness of the cylindrical supporting body is 3 mm or less.

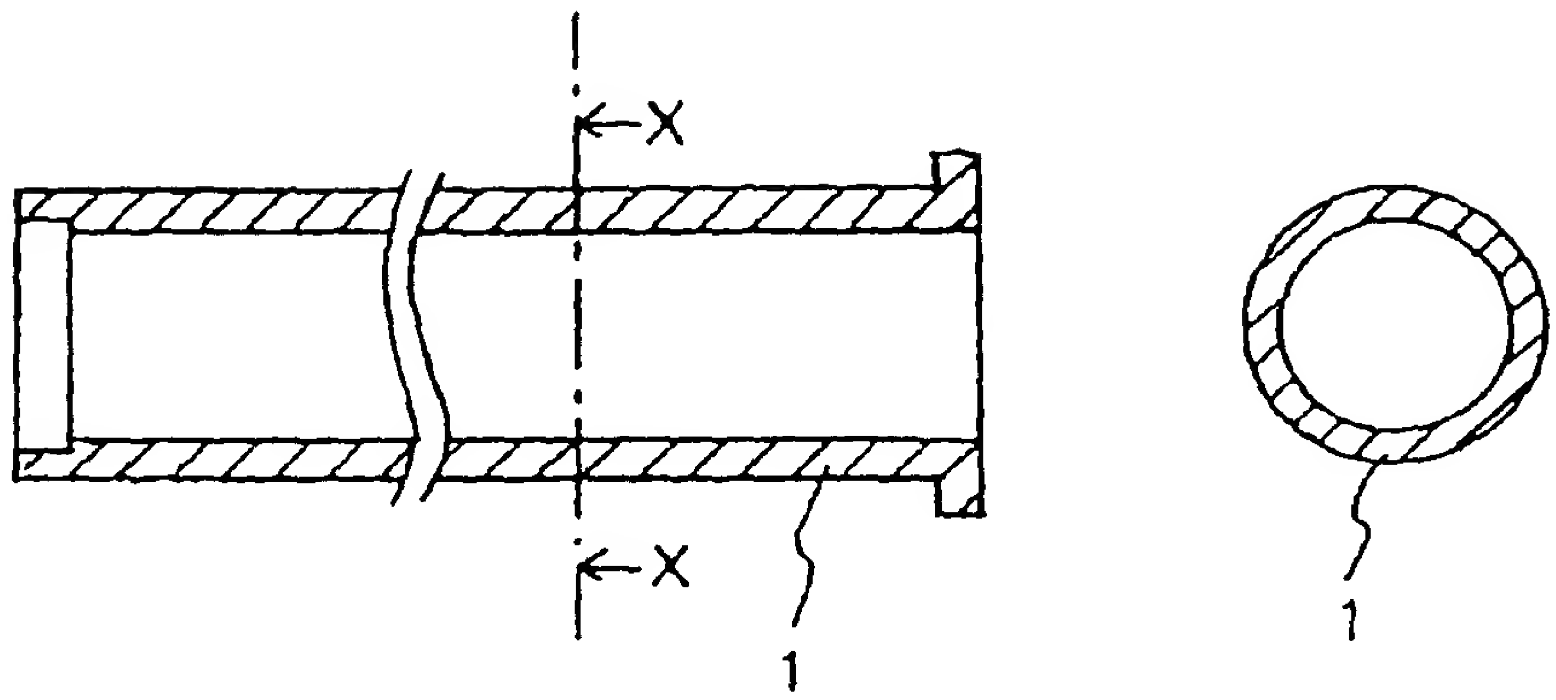
10. A manufacturing method of a cylindrical supporting body wherein a material 10^4 Ω cm in volume resistivity formed by blending a crosslinked-type polyphenylenesulfide resin as a main component with a highly conductive carbon black 10^{-1} Ω cm or less in volume resistivity is injected into a metal mold for the cylindrical supporting body.

11. The manufacturing method of a cylindrical supporting body of Claim 10 wherein the metal mold for injection-molding is heated within a range of 120° to 150°C.

12. The manufacturing method of a cylindrical supporting body of Claim 10 or 11 wherein filling time of an injection-molding material is within the range of 0.05 to 2.5 seconds.

13. The manufacturing method of a cylindrical supporting body of any of Claims 10 to 12 using a metal mold wherein a core mold is finished to have a surface roughness of 1 µm or less at the maximum height (R_{max}) and a draft angle of 0.15° to 0.25° on one side, wherein the inner surface of the cavity mold does not have a draft angle, is electroformed with a nickel alloy, is finished to have a surface roughness of 1 µm or less at the maximum height (R_{max}), and has inside of the end face that contacts a fixed mold a stage section via which a material is filled using a side gate method, and wherein the fixed mold is provided with at least three sprig knocks at its end face opposite to the circumference of the end face of the cavity mold to ensure that when the mold is opened, the injection-molded product remains in the cavity mold due to the effect of the spring knock.

Fig.1



(a) (b)

Fig.2

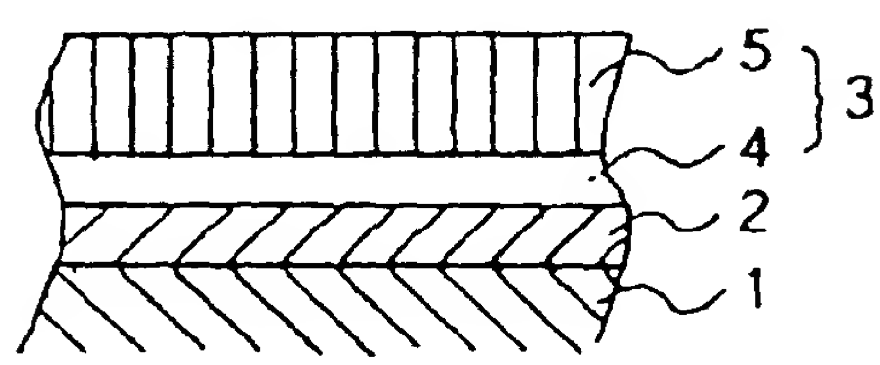


Fig.3

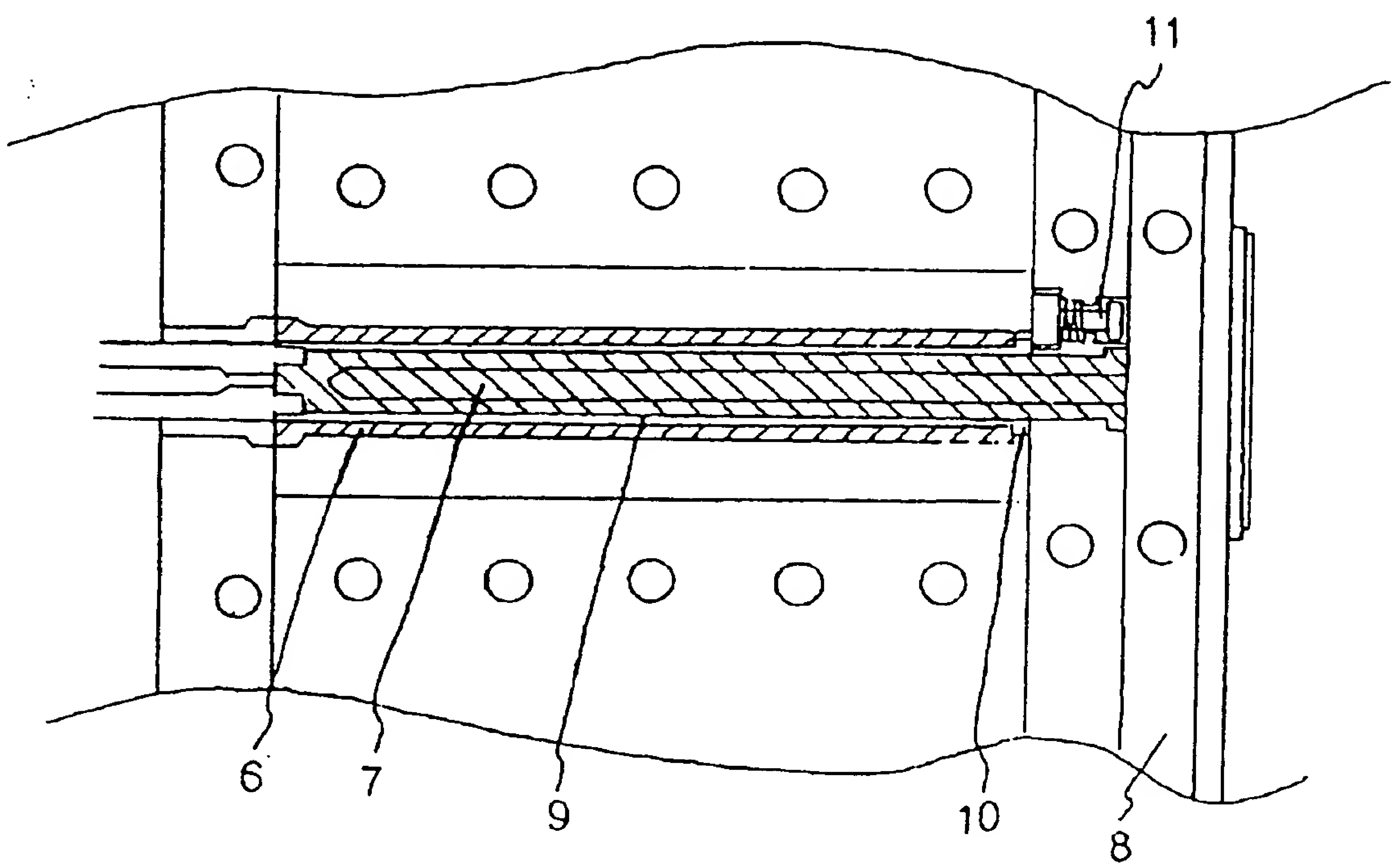


Fig.4

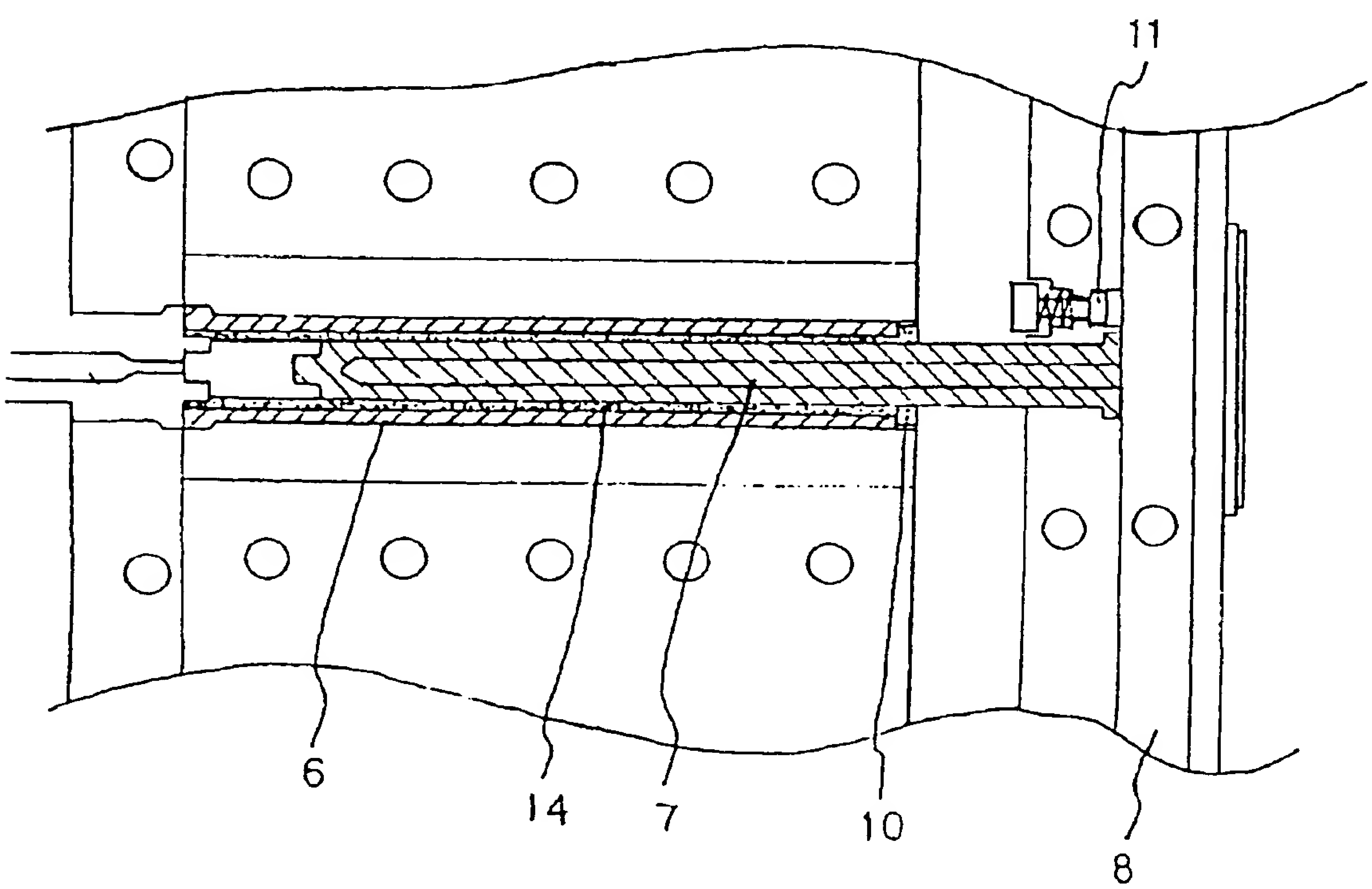


Fig.5

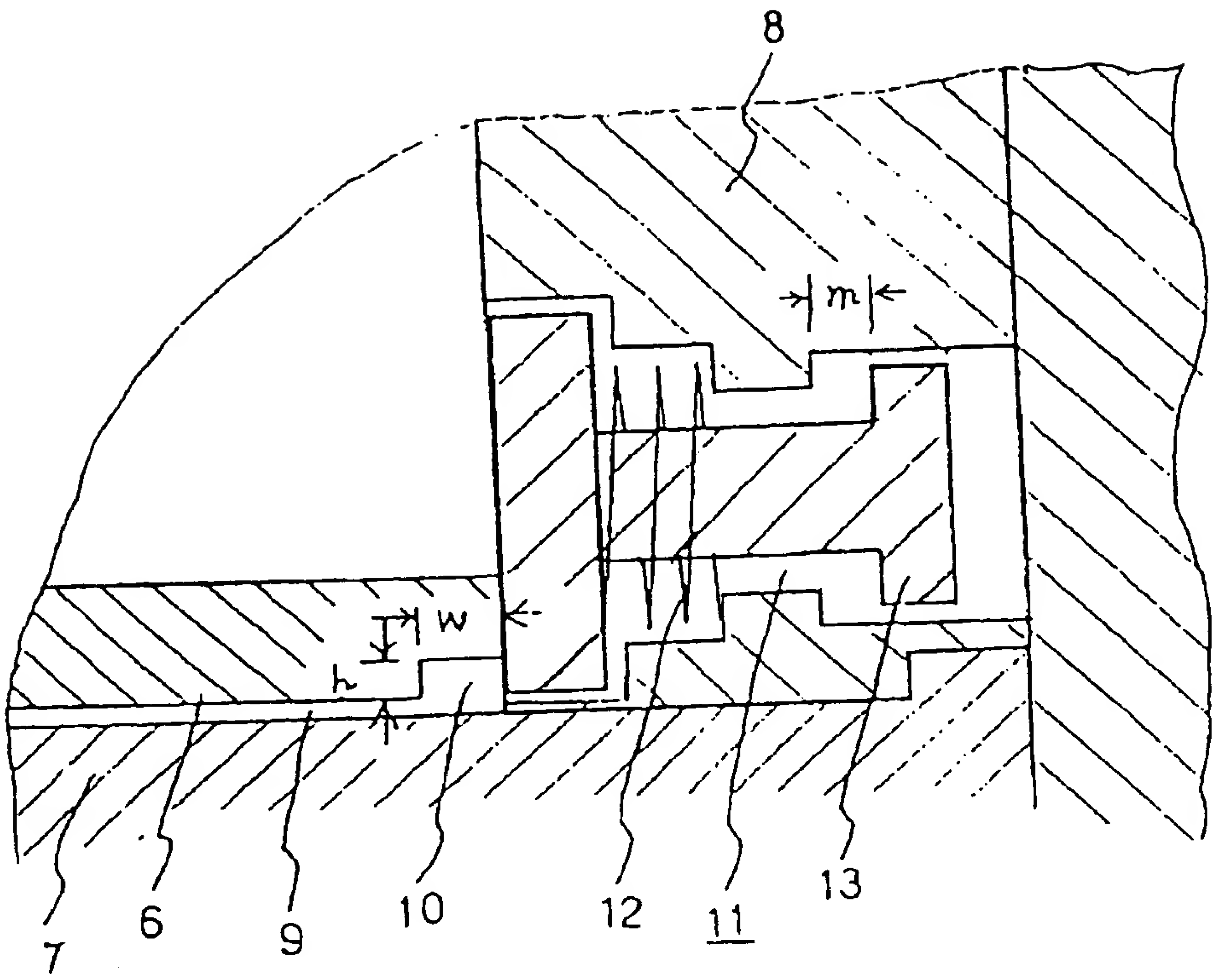
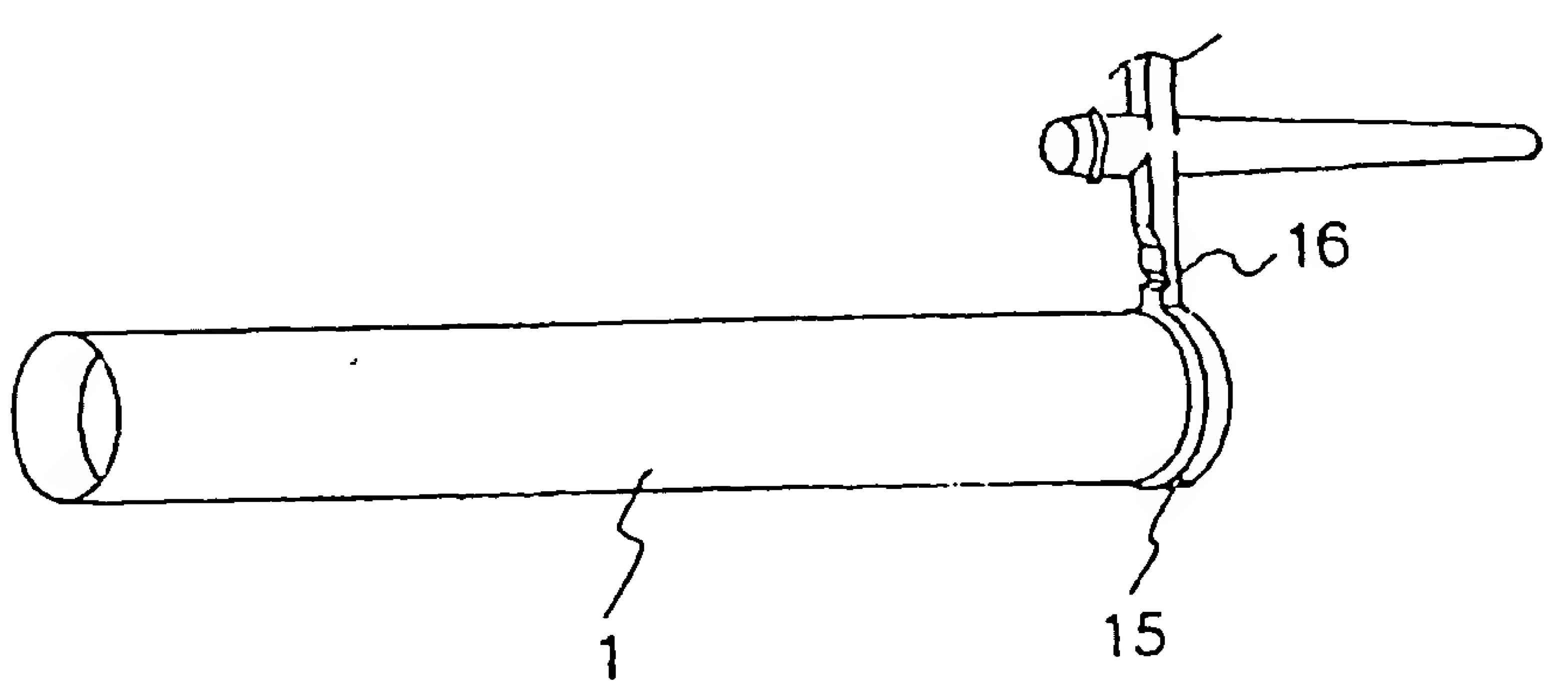


Fig.6



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EUROPEAN SEARCH REPORT

Application Number

EP 94114787.8

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 6)
D,A	US - A - 4 645 327 (KIMURA) * Abstract; column 15, line 44 - column 17, line 41 * & JP-B-90 017 026 --	1-13	G 03 G 15/16 C 08 L 81/02 B 29 C 45/00
A	DE - A - 3 935 140 (BAYER) * Totality * ----	1,2,4, 5	

TECHNICAL FIELDS SEARCHED (Int. Cl.6)

G 03 G
C 08 K
C 08 L
B 29 C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	27-12-1994	SCHÄFER

CATEGORY OF CITED DOCUMENTS

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